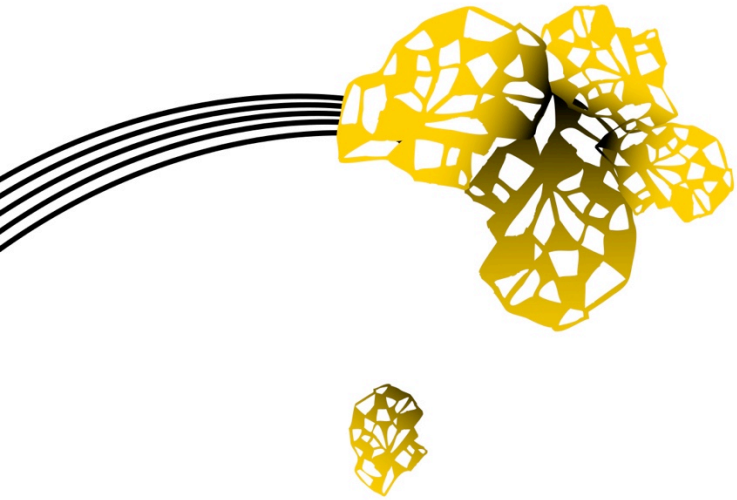
UNIVERSITY OF TWENTE.

EE MODULE 11 – ELECTRONIC SYSTEMS DESIGN

PROJECT INTRODUCTION – FEBRUARY 3RD 2020



CONTENTS

- Project subject and roles
- Project phases and timeline
- Supervision, Administration and Grading
- Possible directions and focus
- Materials

MODULE ELEMENTS

Module contains diverse set of courses ('T-shaped'):

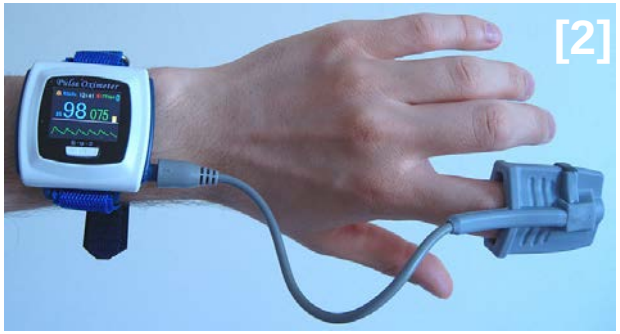
- Systems Engineering — complex system design
- Embedded Signal Processing — signal processing (duh!)
- Philosophy of Technology and Design — human machine interaction

- Project: connects all courses together

PROJECT SUBJECT: WEARABLE MEDICAL DEVICE

- Cost of healthcare is exploding
- Wearables are very popular

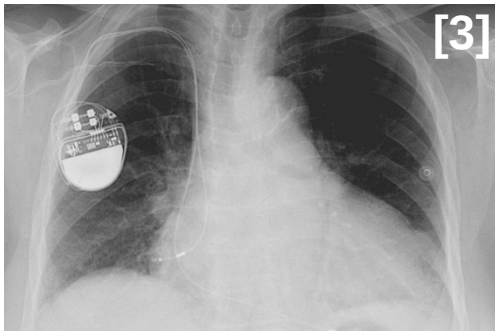
} Opportunities!



- Design of a wearable medical device: multi-disciplinary topic!
  - Human-machine interaction

    (what do we want from it and how do we use it?)
  - Design

    (what is an attractive design, which still has acceptable comfort and performance)
  - Electronics (signal acquisition, transducers, amplifiers/filtering, communications)
  - Signal processing (communications, filtering, feedback, data reduction)
  - Software (interface, control, privacy, security, updates, app/cloud/…)



[1] https://bits-chips.nl/artikel/wearable-ultrasound-from-nijmegen-senses-your-ballooning-bladder/
[2] https://www.healthgazette24.com/diagnostic-wearable-medical-devices-market-to-witness-huge-growth-cleveland-medical-device-fitbit-medtronic-omron-healthcare-polar-electro/37411/
[3] https://newatlas.com/implants-jamming-wireless-attacks/18927/

PROJECT ROLES

We, (the supervisors) represent a traditional medical company that wants to enter the wireless medical device market

- As in real life, note that we might not always know precisely what we want nor agree on it.
- The SysEng supervisors act as advisors to help you manage such a complex project

You, (the students) represent an upcoming electronic design studio, hired to:

- Find out what users want from a wearable medical device
- Design one with a good trade-off between cost and capabilities
- Produce a demonstrator

PHASES

- First part is ’design exploration’ a.k.a. feasibility/architecture study
  - Find a place in e.g. the design-lab for your discussions and brainstorm
  - Present the results in a poster presentation and in a system design & project plan: **March 17th**
    - Supervisors with different roles (SysEng, PoT, Tech) will visit you during the poster presentation, so prepare for different audiences.

- Second part will be about the actual design and prototyping
  - Part of the WEST zaal is reserved for electronics experiments (shared with module 3)
  - Design-lab can be used for e.g. enclosure prototyping
  - Present your results and prototype on **April 15th**

SUPERVISION

Weekly meetings with the project/ESP- & SysEng-supervisors

- 30 minutes per group on Monday (project/ESP) & Tuesday (SysEng)
- Schedule will be posted on Canvas
- Prepare, the meetings influence the project grade!
- Present & discuss: Progress, Issues, Plans

For questions and guidance outside these meetings, contact:

- Project supervisors
- PhD-student @ Biomedical Signals & Systems (BSS) group: per email [info TBD]
- Bert-Jan van Beijnum (BSS): walk-in on Fridays 12:30-13:45 in ZH212
- Students and staff at University (plenty of expertise in every field)
- Other (If you ask nicely people tend to have time: make appointments)

ADMINISTRATION

- You'll work on the project in **groups of ~9-11 people** (enrollment via Canvas)
- You are responsible for managing your group and various roles within the group
- **Weekly meetings** with supervisors; first few weeks everybody should be present
  - Use this to discuss technical requirements, strategy, solutions, …
  - Starting from week 5 (March 2), groups may send delegation
  - Be prepared! Ask questions and/or tell story. Have pre-discussions yourselves.
- Each student will keep track of a **time-sheet**, shared within the project group
  - Mention spent time and subject
- At the end, supervisors will use the output (reports, presentations, prototype, time-sheets, …) and assign **one grade per group**
  - Within a project team, you will have to distribute this grade yourself (with a maximum difference of 2 between the various participants)

PROJECT FOCUS

- Assignment is much broader than you might think and requires many areas of expertise
  - Commercial development of such a device would cost >10 man-years and >€10,000,000
- Create a *complete* plan
  - Keep actual design work limited to some key areas that have overlap with the courses
  - PoT: human-machine interaction, design
  - SysEng: solutions to conflicting constraints

  } Use given toolboxes!
  - ESP: signal processing aspects with analysis and simulation results (Ltspice/Matlab)

- **Aim to have working prototype at the end**
  Prototype ≠ Final finished product

WEARABLE MEDICAL DEVICES MARKET

Global Wearable Medical Devices Market Size (US$ Mn), 2018 to 2026

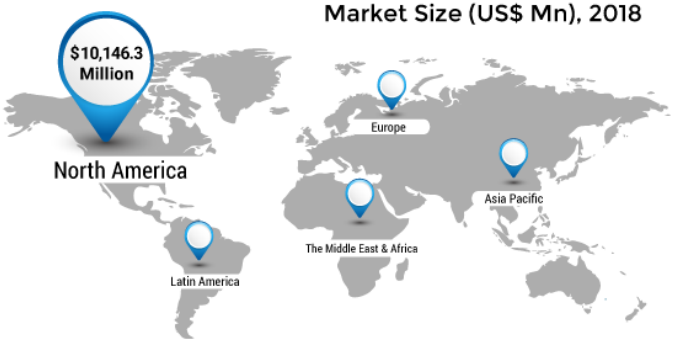
2018
$ 24,571.8 Mn

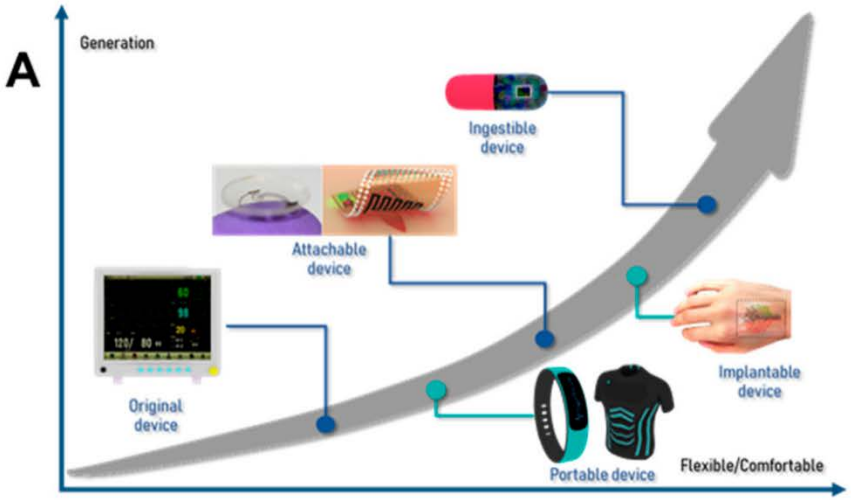
2026
$ 139,353.6 Mn

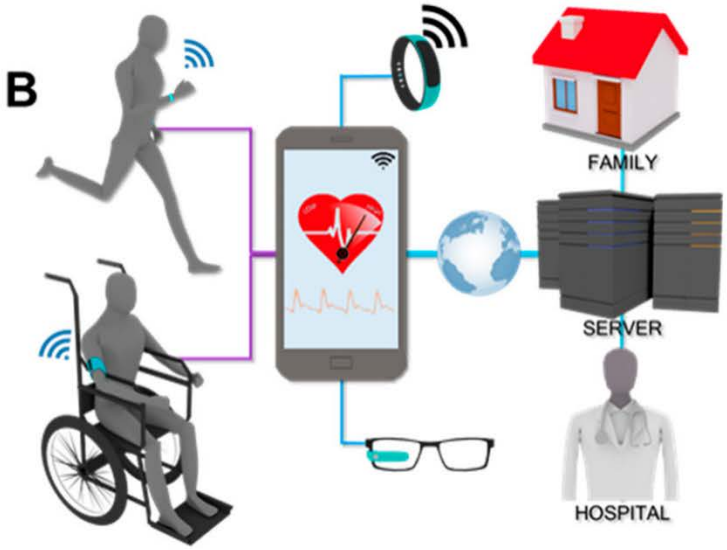
Global Wearable Medical Devices Market Share, By Product, 2018

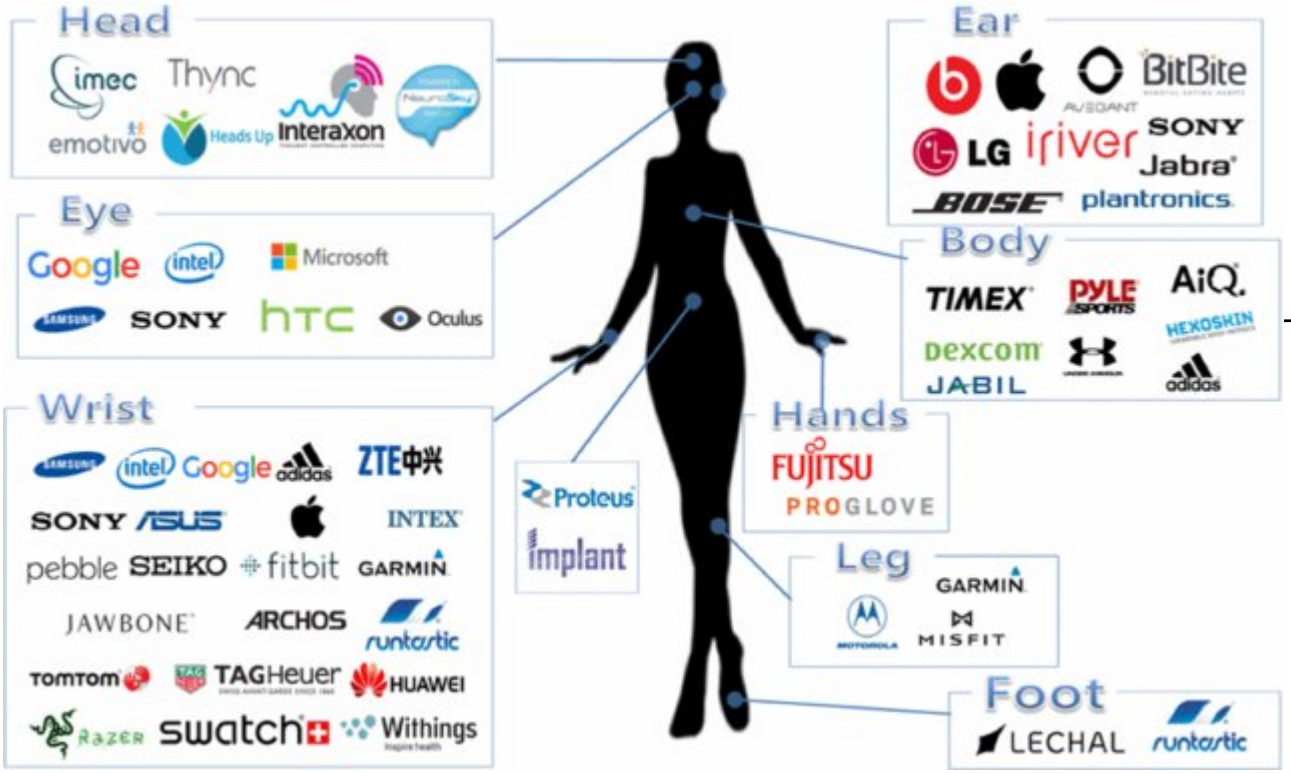
- Diagnostic & Monitoring Wearable Devices
- Therapeutic Wearable Medical Devices

North America Wearable Medical Devices Market Size (US$ Mn), 2018








Head
imec
Thync
emotivo
Heads Up
InteraXon
Eye
Google
intel
Microsoft
SAMSUNG
SONY
htc
Oculus
Wrist
SAMSUNG
intel
Google
adidas
ZTE中兴
SONY
ASUS
INTEX
pebble
SEIKO
fitbit
GARMIN
JAWBONE
ARCHOS
runtastic
TOMTOM
TAG Heuer
HUAWEI
Razer
swatch
Withings
Proteus
implant
Ear
BitBite
LG
iriver
SONY
Jabra
BOSE
plantronics
Body
TIMEX
PYLE SPORTS
AiQ
HEXOSKIN
dexcom
JABIL
adidas
Hands
FUJITSU
PROGLOVE
Leg
GARMIN
MOTOROLA
MISFIT
Foot
LECHAL
runtastic


PHILIPS
The MRI Scan
Experience

POSSIBLE TECHNICAL DIRECTIONS

- Signal processing:
  - Optimize SNR to enable certain diagnostics, while staying within power budget
  - Data reduction to transmit less from sensor to readout-unit
  - Adaptive filtering to accommodate e.g. time-variant skin impedance
- Communication
  - Wired communications → analog prototyping feasible
  - RF communications → better use existing module
- Power efficiency
  - Efficient conversion from battery voltage to (various) needs of electronics
  - Data reduction, choice of communications
  - Offloading to cloud / mobile phone / …
- You'll hear more during Project Lecture 1 (Monday Feb 3, 13:45-15:30)

AVAILABLE MATERIAL

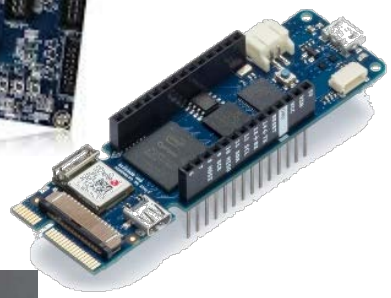
- FPGA board for signal processing and data conversion

  Terasic DE1-SoC also used in module 5,

  can be borrowed from Bert Molenkamp

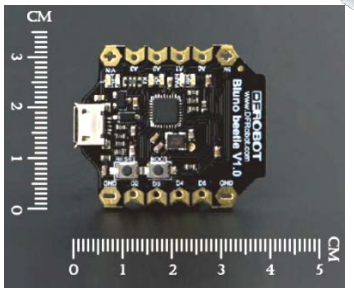
- Arduino-based FPGA (MKR Vidor 4000)

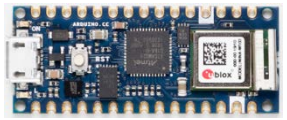
  smaller, more power efficient, less capable than DE1-SoC



- Small form-factor wireless modules

  Beetle BLE and Arduino Nano 33 IoT





Feel free to use something else, but motivate your requirements

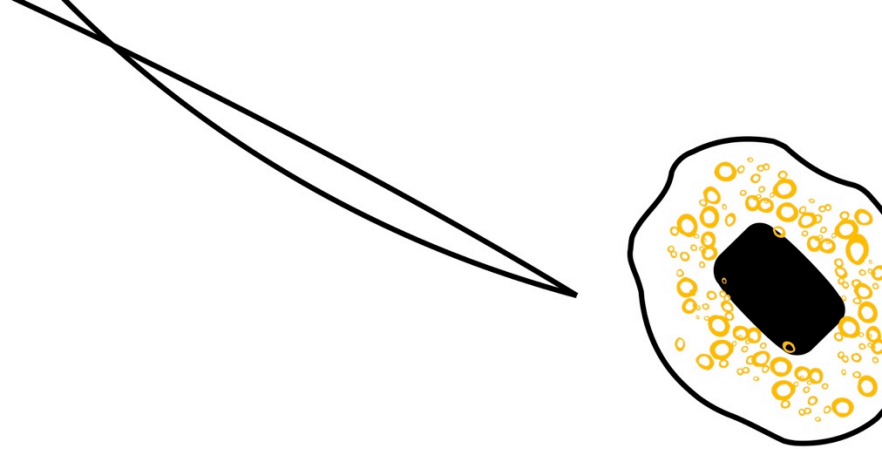
(there is no fixed budget, but goal is to make a cost-effective design)

NEXT STEPS

- Choose project groups through Canvas
  - Groups of 9 persons, make sure to enlist **today!**
- Groups will be finalized tomorrow. After tomorrow: meet with your group
  - If you do not want to be a number, choose a group name and pass it to me
- Start with the introductory phase (use PoT and SysEng tools)
  - Who will be your target audience and why
  - What will you be making and why
- See you on Monday & Tuesday afternoons for the meetings
  - First Monday meeting will mostly be an introduction, who is who, etc
  - For later meetings: show progress, issues, plan
- **Read the module manual for details (available on Canvas)!**

LAST YEARS: WIRELESS SPEAKER

UNIVERSITY OF TWENTE.



GOOD LUCK & ENJOY!

QUESTIONS?